USE OF REMOTE LABORATORIES FOR MATERIAL SCIENCES IN EDUCATION AND RESEARCH.

Arras P.[1], Kozik T.[2], Tabunshchyk G.[3]
[1] PhD., Docent KU Leuven, Leuven, Belgium (peter.arras@kuleuven.be)
[2] DrSc., Prof UKF, Nitra, Slovak Republic (tkozik@ukf.sk)
[3] PhD., Assoc Prof ZNTU, Zaparizhzhya, Ukraine (galina.tabunshchik@gmail.com)

Advancements in the development of materials and technologies significantly contribute in successful progress in natural sciences and technical branches. But as teaching time is a limited resource in education it is necessary to explore and propose new and more efficient ways of offering the knowledge on new findings to students. In this context we explore the use of remote experiments in the field of material sciences as a new teaching method.

Introduction

There is an increasing amount of new materials and better use of materials. So universities faces several problems: teaching engineers – in particular design engineers – requires for an important part of the curriculum to devote to material sciences to teach on these new findings. Teaching engineers also means offering ample opportunities for experimenting and training practical skills. As teaching resources (both in teaching time and in laboratory means) is limited and mobility of the students is growing each year new methods for transferring knowledge and skills needs to be explored.

University nowadays form the basis for research platforms for business. Similar problems are faced in the research sphere - limited resources with international teams located in different countries.

Methods and materials

Considering the new learning approaches, we also need to take into consideration self-learning and distant learning. One of the examples of good practice is developed in KU Leuven technology Campus De Nayer with the e_learning environment CALM (Computer Aided Learning Module). CALM (Computer Aided Learning Module) is an internet supported e_learning environment with the use of virtual and remote laboratories to teach material sciences (see Fig.1). [1]

Fig. 1 View of the CALM e_learning environment

The CALM is a learning environment containing theoretical contents and backgrounds, laboratory manuals for the hands-on labs at university, and a virtual and a remote lab for the testing on the difference between material and shape stiffness (see 2). CALM is aimed to be used in the classroom sessions, as help during hands-on labs and for self-study. The learning environment and the labs were tested with bachelor students in engineering to test the effectiveness on the learning. Results showed no difference in knowledge between students using the remote lab and students using the hands-on labs for the bending test. The bending test is used to measure Young's modulus.

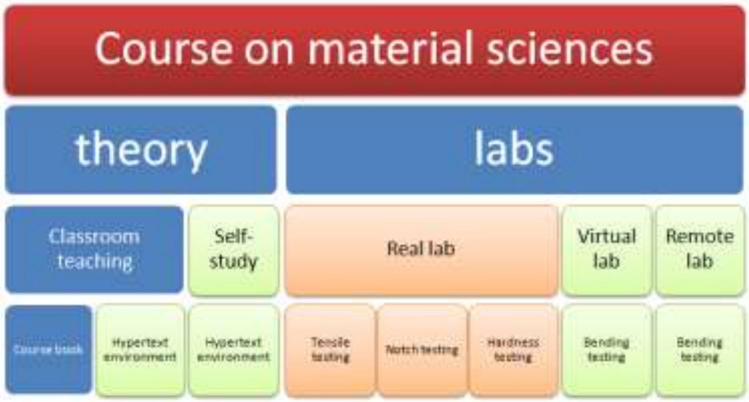

Fig. 2 Structure of the CALM.

As mentioned, an important role is given to remote labs in the CALM. The remote labs can be classified as online interactive labs constructed as virtual or as interactive remote experiments (RE). The RE in CALM is a 2-point bending test, where displacements are read on a simple reading scale. As such it is close to an hands-on experiment: different parameters can be modified (force, section) and no automated readings is provided so that students needs to use the experimental values themselves to calculate Y oung's modulus and need to also calculate the accuracy of their results considering accuracy of readings, measuring tools et cetera. These outcomes were chosen so that RE can really substitute the hands-on 3-point bending test lab with the same learning goals. The construction of the RE was kept simple with standard pneumatic components to make a robust, safe and easy to maintain lab. This setup allows the re-use of components and offer possibilities to more easily rebuild the lab for new materials and different experimental approaches.

Extended possibilities of the RE: CALM and its' labs are designed for educational purposes but can be extended for more research purposes.

The idea is to use the infrastructure not only for teaching. By extending the supporting study materials, it can be used as background information for more different experiments. The RE-environment can be modified and enlarged with all sorts of the non-destruction experiments. This can help to save resources for experiments and to synchronize the work of a distributed team. As an example we refer to another remote laboratory for material sciences at http://remotelabsup.fe.up.pt/experiments.htm . There is a remote lab with a 2-point bending test. This system is used by the mechanical engineering students to validate experimentally the displacements calculated by means of FEA for the different loads. [2]

The use of RE will become more popular in education and research when the technical problems concerning internet access and imaging will have been solved. Many existing RE struggle with the technical solutions for streaming video and for security on the access to the labs [3]. Open access labs, as were once the mainstream idea in the RE-community, have mostly been abandoned as maintenance costs are too high. Most RE nowadays have access exclusively for the own students of the home university. However, networks of universities working closely together can benefit from common RE-platforms and can easily exchange expertise on this. [4]

Conclusion

Constructing a mechanical RE with similar possibilities as a real lab was a challenge. The learning outcomes reached through the use of the RE are the same as in the hands-on labs. The CALM and RE proved to be very helpful to stimulate bachelor students in their study of material sciences.

The construction of a RE needs careful planning – both from the technical side and the didactical point of view [5] . When working on RE and internet supported learning environments users can benefit a lot if a network of universities work on a common platform. The knowhow, contents and use will be stronger and more widespread if more teachers work on the same experiments. The network is also a guarantee that the didactical part of the learning environment is covered, which is otherwise too often forgotten.

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